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PENNSTATE

FINAL REPORT

Advanced Methods for Computational Electromagnetics: Finite Difference Time Domain

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INTRODUCTION

NASA Ames Research Center provided a Research Grant to the Pennsylvania State University to support "Advanced Methods for Computational Electromagnetics: Finite Difference Time Domain". This grant had a period of performance starting July 15, 1993 for 15 months. The Technical Officer for this grant is Alex Woo, Applied Aerodynamics Branch, 227-6.

The goal of this effort was to extend the applicability of the Finite Different Time Domain Method (FDTD) to different materials, to investigate new algorithms based on the Finite Volume Time Domain (FVTD) method, to implement efficient versions on highly parallel computers, and to validate the results. As a part of this process technical briefings, reports, and papers were generated. These are described and referenced in the next section of this report.

PROJECT SUMMARY

The activities supported by this research grant are described in two reports, and the delivered computer code is described in three manuals and an installation guide.

The Theory Manual [1] is an extensive report consisting of 132 pages. This report describes the technical progress made under this grant. The topics covered in this report include non-reflecting boundary conditions, porting the computer codes to massively parallel computers, validation of the ported codes, extension of computational fluid dynamics methods to electromagnetics, thin lossy coatings over perfect conductor, frequency-dependent materials, and anisotropic materials.

The time domain computer codes that were ported to the massivel parallel computers are described in three users manuals, one each for the transient FDTD [2], the steady state FDTD [3], and the transient FVTD [4] codes. In addition a general installation and porting guide [5] covering use of all of the codes on the massively parallel computer was written.

A significant part of the effort was to validate the FDTD and FVTD codes as ported to operate on the massively parallel computer. This validation effort includes calculation of the scattering cross sections and comparison with measurements for most of the targets reported on by the Electromagnetic Code Consortium (EMCC). These validation results are reported in the Test Case Manual [6].

All of the manuals [1-6] have been delivered previously to NASA Ames.

REFERENCES

1. Raymond J. Luebbers and Lyle Long, "Theory Manual Draft--Advanced Methods for Computational Electromagnetics: Finite Difference Time Domain", NASA Grant NAG 2-867, The Pennsylvania State University, 132 pp, January 17, 1994.

2. Raymond J. Luebbers and Joseph Schuster, "User's Manual for Three Dimensional CM-5 FDTD Code for Transient Scattering from Dielectric and Magnetic Materials," NASA Grant NAG 2-867, The Pennsylvania State University, 18 pp, May 4, 1994.

3. Raymond J. Luebbers and Joseph Schuster, "User's Manual for Three Dimensional CM-5 FDTD Code for Steady State Scattering from Dielectric and Magnetic Materials," NASA Grant NAG 2-867, The Pennsylvania State University, 16 pp, May 4, 1994.

4. Lyle N. Long and Vineet Ahuja, "User's Manual for Three Dimensional FVTD Code for Transient Electromagnetic Scattering," NASA Grant NAG 2-867, The Pennsylvania State University, 19 pp, May 4, 1994.

5. Lyle N. Long, "Installation and Porting Guide for the Penn State Parallel FDTD and FVTD Codes, NASA Grant NAG 2-867, The Pennsylvania State University, 7 pp, May 4, 1994.

6. Raymond J. Luebbers et al, "Test Case Manual Draft--Advanced Methods for Computational Electromagnetics: Finite Difference Time Domain", NASA Grant NAG 2-867, The Pennsylvania State University, 94 pp, September 1994.